# Intramolecular Reactions of Benzylic Azides with Ketones: Competition between Schmidt and Mannich Pathways

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The Lewis acid-promoted reactions of benzylic azides with ketones can proceed by two major pathways. The azido-Schmidt reaction involves simple addition of azide to the ketone followed by rearrangement and ring expansion. In addition, benzylic azides can undergo prior rearrangement to afford iminium ions that can subsequently participate in a Mannich reaction. A series of ketones containing an α $CH_2(CH_2)_nCH(N_3)Ph$ substituent ($n$ = 1−3) was prepared to investigate the dependence of products on ketone ring size and tether length. For all ketones examined, good yields of bicyclic lactams arising from intramolecular Schmidt reaction were obtained when a four-carbon linker was used ($n$ = 1 in the above formulation), but Mannich products predominated for the longer tethers examined ($n$ = 2, 3).

The intramolecular Schmidt reaction of ketones and alkyl azides[1] is a broadly useful process that has emerged as a valuable tool for alkaloid synthesis.[2] In contrast, the intermolecular reaction of unfunctionalized alkyl azides is much less facile and is subject to severe limitations with respect to usable ketone substrates (Figure 1a).[3] For example, only four- and six-membered rings react efficiently under normal circumstances, and even moderate steric hindrance near the carbonyl can effectively shut down the addition of azide to the carbonyl group. We have recently reported that, when benzyl azide is used as the nucleophile, an alternative pathway involving rearrangement of the azide to an *N*-phenyliminium species can occur, followed by trapping by the enol form of the ketone in a variation of the Mannich reaction (Figure 1b).[3b,4] Similar rearrangements of benzylic azides or (trimethylsilyl)methyl azide have been reported by Pearson[5] and Kuwajima,[6] respectively. In general, these azido-Mannich reactions intervene in cases in which the Schmidt process is rendered unfavorable.

In our continuing investigations of the intramolecular Schmidt reaction in organic synthesis, we have considered carrying out the reaction with substrates in which the azide group is on a benzylic carbon. An early indication that such substrates might prove problematic was evident in the attempted formation of a bridged lactam from the substrate shown in eq 1 (this would have provided the ring system of lycorane alkaloids).[7] In this instance, only loss of $N_2$ to afford nitrile, but neither a Schmidt nor Mannich process, was observed.

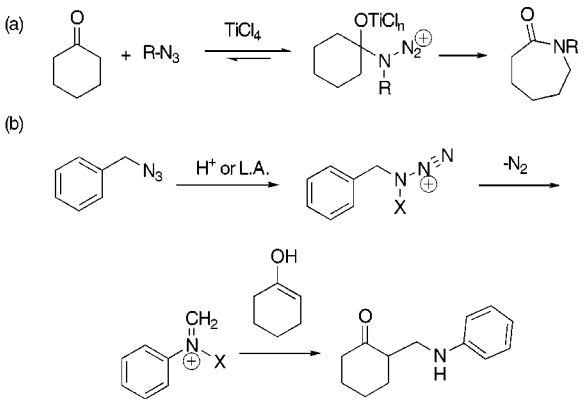
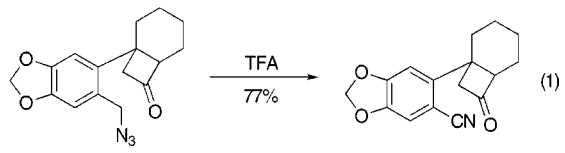



**Figure 1.** (a) Azido-Schmidt reaction of an alkyl azide with cyclohexanone. (b) Acid-promoted rearrangement of benzyl azide followed by Mannich reaction with cyclohexanone.




The rational use of the intramolecular Schmidt reaction of ketones with benzylic azide nucleophiles in complex synthesis would require the delineation of which substrates are amenable to this process. In this paper, we report the results of a study designed to examine the competition between the intramolecular Schmidt and Mannich pathways. To accomplish this, we prepared a series of benzylic azides connected to ketones by tethers

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(2) (a) Le Dréau, M.-A.; Desmaële, D.; Dumas, F.; d'Angelo, J. *J. Org. Chem.* **1993**, *58*, 2933−2935. (b) Aubé, J.; Rafferty, P. S.; Milligan, G. L. *Heterocycles* **1993**, *35*, 1141−1147. (c) Wendt, J. A.; Aubé, J. *Tetrahedron Lett.* **1996**, *37*, 1531−1534. (d) Iyengar, R.; Schildknegt, K.; Aubé, J. *Org. Lett.* **2000**, *2*, 1625−1627.

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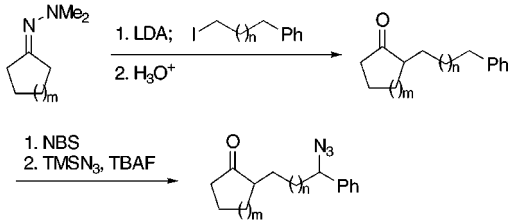
**Scheme 1**




| compound | n | m |
|---|---|---|
| **1** | 1 | 1 |
| **2** | 1 | 2 |
| **3** | 2 | 1 |
| **4** | 2 | 2 |
| **5** | 3 | 1 |
| **6** | 3 | 2 |
| **7**, n = 1<br>**8**, n = 2<br>**9**, n = 3 | | |

containing from four to six carbon atoms and subjected them to prototypical protic and Lewis acid conditions. Previous work[1] has established that cyclic ketones containing a three-carbon spacer between the carbonyl and azide do not undergo the azido-Schmidt reaction and were therefore not included in this study.

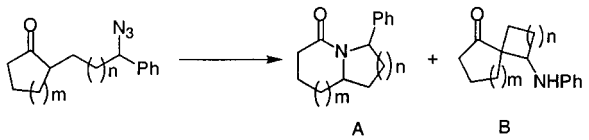
## Results and Discussion

The substrates required for this study were prepared via the straightforward methods shown in Scheme 1. After alkylation of the appropriate dimethylhydrazone and hydrolysis, the benzylic azide group was installed by successive bromination and azide displacement, generally without detailed characterization of the bromide intermediate. Cyclic keto azides **1**−**6** were prepared and examined as a 1:1 mixture of diastereomers. Acyclic congeners **7**−**9** were synthesized in an analogous fashion (not shown). The yields of the syntheses were acceptable (22-75% overall) and readily afforded several hundred milligrams of each required compound.

Our previous experience in the intermolecular series indicated that, in general, Lewis acid treatment gave the highest yields of Schmidt insertion products whereas strong protic conditions, particularly triflic acid (TfOH), seemed best for the azido-Mannich reactions.[3b] (It is possible that $TiCl_4$ does not promote the Mannich reaction because of competing enolization of the ketone.) Furthermore, intramolecular Schmidt reactions of substrates in which the carbonyl and azide components are separated by four carbon atoms proceed well under a variety of protic and Lewis acid conditions, whereas those containing a five-carbon tether require treatment with $TiCl_4$.[1] Accordingly, both triflic acid and $TiCl_4$ conditions were tried for most substrates. The results of experiments carried out with substrates containing cyclic ketones are indicated in Table 1.

The overall trends can be summarized along the lines depicted for the substituted cyclopentanones shown in Scheme 2. The only cases in which the Schmidt pathway prevailed were in examples containing the optimal four-carbon tether ($n = 1$). Thus, the attack of azide onto carbonyl activated by either Lewis or protic acids is fast enough to afford an azidohydrin intermediate that can then go on to bicyclic lactam. Interestingly, the same products were observed throughout when either TfOH

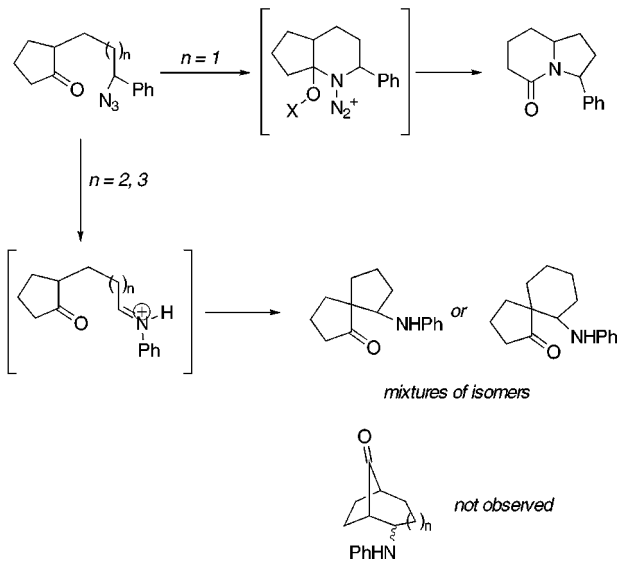
**Table 1. Lewis-acid Mediated Reactions of Hydroxy Azides 1−6**




| | | | | | product | |
|---|---|---|---|---|---|---|
| entry | azide | n | m | conditions | A (%) | B (%) |
| 1 | **1** | 1 | 1 | $TiCl_4$ | **10** (50) | *a* |
| 2 | **1** | 1 | 1 | TfOH | **10** (60) | *a* |
| 3 | **2** | 1 | 2 | TfOH | **11** (52) | *a* |
| 4 | **2** | 1 | 2 | $TiCl_4$ | **11** (81) | *a* |
| 5 | **3** | 2 | 1 | TfOH | *a* | **12** (46) |
| 6 | **3** | 2 | 2 | $TiCl_4$ | *b* | *b* |
| 7 | **4** | 2 | 2 | TfOH | *a* | **13** (55) |
| 8 | **5** | 3 | 2 | TfOH | *a* | **14** (36) |
| 9 | **6** | 3 | 2 | TfOH | *a* | **15** (31) |

Notes: Yields are not optimized and reflect purified product. [a] This product was not observed. [b] Starting material decomposed.

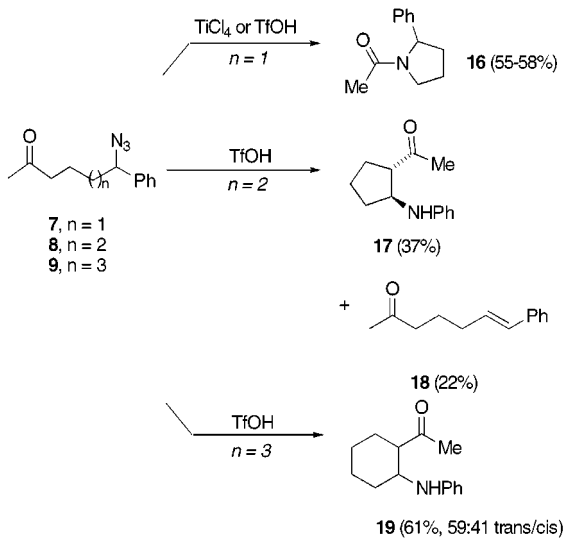
**Scheme 2**




or $TiCl_4$ were used, with only modest yield differences being observed between the two conditions.

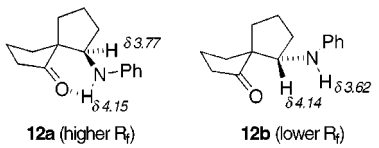
Schmidt reactions of substrates with the two-carbon longer tether lengths examined would require formation of a seven- or eight-membered azidohydrin ring. The fact that only Mannich products were obtained suggests that the slower formation of such rings gives the phenyl group time to take part in C → N migration, affording the iminium species shown. This migration is by far more efficient when TfOH is used to trigger the reaction, although some Schmidt product was previously observed in intermolecular reactions carried out under these conditions.[3b] Intramolecular attack of the enol on this species readily affords the spirobicyclic products in modest yield. In each case, only spirocyclic products were observed, although bridged adducts could have reasonably resulted from the reaction of the alternative enol with the iminium ion. It is worth noting that the corresponding reaction of the azide where $n = 1$ could have also proceeded to afford bridged adducts (or products resulting from decomposition of iminium ion), but this route was not taken. In either case, it is possible that the formation of the more stable enol form of the ketone directed the regiochemistry of the Mannich reactions.

**Scheme 3**




Overall, it appears that the kinetic competency of the Schmidt reaction pathway, or lack thereof, determined the product distribution for all of these examples.

In both reaction types, approximately equimolar mixtures of stereoisomeric products were observed, but for different reasons. The intramolecular Schmidt reaction products merely reflected the 1:1 mixture of keto azides that went into the reaction. In the intramolecular Mannich cases, the achiral enol intermediate could have afforded a single stereoisomeric Mannich adduct, but both isomers were obtained in comparable (1.0−1.2:1) amounts. The stereochemistry of each isomer was tentatively assigned through reasoning based on several spectroscopic and chromatographic trends throughout the series. In each case, the isomer that had the higher $R_f$ value (silica gel, EtOAc/hexane) had both a lower field chemical shift for the NH proton in $CDCl_3$ ($\Delta\delta$ 0.53−0.69 ppm) and a higher field shift for the proton on the carbon containing the phenylamino group ($\Delta\delta$ 0.34−0.87 ppm). One example is given below, with the rest of the relevant data available in the Experimental Section. These observations are consistent with the higher $R_f$ (and presumably less polar) compound enjoying a greater degree of intramolecular hydrogen bonding as shown for **12a** below.[8] This isomer is therefore assigned as having the carbonyl group and the phenylamino substituent in a cis disposition. In addition, the proton adjacent to the phenylamino group in the more polar isomer is deshielded due to close proximity to the carbonyl group (e.g., **12b**).




**12a** (higher $R_f$) **12b** (lower $R_f$)

An analogous acyclic series was briefly examined, with essentially the same results (Scheme 3). Using either protic acids or $TiCl_4$, the shorter four-carbon tether gave exclusively intramolecular Schmidt product whereas the two longer tethers preferentially undergo the rearrangement/Mannich reaction sequence. Again, it is interesting to note that in no case was addition of the alternative enol to the iminium ion observed, although in this case such a reaction would result in a product containing an endocyclic ketone but without the steric stigma of producing a bicyclic product. In addition, a previously unobserved reaction pathway leading to known[9] elimination product **18** was observed in the reaction of ketone **8** in this instance only.

In conclusion, the intramolecular reactions of ketones and benzylic azides follow the same overall guidelines as previously reported for the intermolecular examples.[3b] Thus, only optimal intramolecular Schmidt reactions (i.e., those in which the initial azidohydrin formation occurs to give a six-membered ring) can successfully compete with phenyl group migration and lead to insertion. In cases that would require the formation of awkward-sized azidohydrins, only phenyl migration is observed. Once formed, the iminium ions react smoothly, if nonstereoselectively, to afford spirocyclic Mannich adducts that may have some synthetic utility.

## Experimental Section

**General Information.** General protocols have been published.[10] The following phenylalkyl-substituted ketones are known compounds: 2-(3′-phenylprop-1′-yl)cyclopentanone,[11] 2-(3′-phenylprop-1′-yl)cyclohexanone,[12] 6-phenyl-2-hexanone,[13] and 7-phenyl-2-heptanone.[14] Additional new compounds may be found in the Supporting Information.

**General Procedure for the Alkylation of Hydrazones.** To a solution of hydrazone (1.5 mmol) in THF (20 mL) at 0 °C was added *n*-BuLi (1.65 mmol, 2.5 M in hexanes). The resulting cloudy solution was stirred for 30 min and subsequently quenched by dropwise addition of alkyl iodide (1.5 mmol) in THF (5 mL). This clear solution was allowed to slowly warm to 25 °C and then stirred for 8 h. To the reaction was then added 2 N $H_2SO_4$ (6 mL), and stirring was continued for 1 h. The mixture was concentrated in vacuo and the aqueous layer extracted with diethyl ether. The combined organic layers were washed with saturated $NaHCO_3$, brine, dried over anhydrous $Na_2SO_4$, and concentrated to yield a dark brown oil. Chromatography (0−20% EtOAc/hexanes) afforded alkylated ketone (0.75−1.4 mmol) as a clear, colorless oil.

**8-Phenyl-2-octanone:** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.30−1.35 (m, 4H), 1.53−1.63 (m, 4H), 2.13 (s, 3H), 2.41 (t, $J$ = 7.5 Hz, 2H), 2.60 (t, $J$ = 7.6 Hz, 2H), 7.16−7.29 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 23.7, 28.9, 29.0, 29.8, 31.2, 35.8, 43.7, 125.5, 128.2, 128.3, 142.6, 209.2; IR (neat) 1715 cm$^{-1}$; MS (CI) *m/e* 205 ($M^+$ + 1); HRMS calcd for $C_{14}H_{21}O$ (M + H): 205.1592, found 205.1595.

**2-(4′-Phenylbutyl)cyclopentanone:** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.26−2.33 (complex, 13H), 2.61 (t, $J$ = 7.2 Hz, 2H), 7.16−7.29 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 20.7, 27.2, 29.4, 29.5, 31.4, 35.7, 38.1, 49.1, 125.6, 128.2, 128.3, 142.5, 221.6; IR (neat) 1735 cm$^{-1}$; MS (CI) *m/e* 217 ($M^+$ + 1); HRMS calcd for $C_{15}H_{21}O$ (M + H): 217.1592, found 217.1596.

**General Procedure for Benzylic Bromination/Azidation of Alkylated Ketones.** To a solution of ketone (0.63 mmol) in $CCl_4$ (10 mL) was added NBS (0.69 mmol). The resulting solution was heated at reflux until TLC indicated

(8) For a discussion of the effect of intramolecular hydrogen bonding on chemical shift, see: Asakura, T.; Toaka, K.; Demura, M.; Williamson, M. P. *J. Biomol. NMR* **1995**, *6*, 227−236.

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the absence of ketone at which time the reaction was cooled to 25 °C and diluted with water. The layers were separated, and the aqueous layer was extracted with $CH_2Cl_2$. The combined organic layers were washed with brine, dried over anhydrous $Na_2SO_4$, and concentrated in vacuo to yield a light brown/yellow oil (0.54−0.63 mmol). In general, the bromides were not characterized but rather directly carried on in the next step. However, in a few cases formation of the bromide was confirmed by $^1$H NMR. For example, the $^1$H spectrum of 2-(3′-bromo-3′-phenylpropyl)cyclohexanone showed a new signal at $\delta$ 4.90 ppm (t, 1H) for the benzylic proton. The corresponding benzylic protons of the hydrocarbon had a signal at $\delta$ 2.60 ppm (t, 2H). To a solution of bromide (0.54 mmol) in THF (20 mL) at 25 °C was added $TMSN_3$ (0.81 mmol) dropwise followed by dropwise addition of TBAF (0.81 mmol, 1.0 M in THF). The mixture was stirred at 25 °C for 24 h and then concentrated in vacuo to yield a thick, brown oil. Chromatography (3% EtOAc/hexanes) afforded azide (0.27−0.45 mmol) as a clear, light yellow oil.

**2-(3′-Azido-3′-phenylpropyl)cyclopentanone (1):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.19−2.39 (complex, 12H), 4.41 (dt, $J$ = 3.1, 6.6 Hz, 1H), 7.25−7.39 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 20.66, 20.67, 26.4, 26.6, 29.55, 29.63, 34.0, 34.3, 38.0, 48.6, 48.7, 66.36, 66.42, 126.8, 126.9, 128.3, 128.8, 139.4, 139.5, 220.6, 220.7; IR (neat) 2110, 1745 cm$^{-1}$; MS (CI) *m/e* 244 ($M^+ + 1$), 201; HRMS calcd for $C_{14}H_{18}N_3O$ (M + H): 244.1450, found 244.1440.

**2-(4′-Azido-4′-phenylbutyl)cyclopentanone (3):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.26−2.35 (complex, 14H), 4.44 (dt, $J$ = 1.8, 7.9 Hz, 1H), 7.30−7.40 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 20.6, 24.2, 24.3, 29.1, 29.2, 29.48, 29.49, 36.07, 36.11, 38.02, 38.04, 48.9, 49.0, 66.09, 66.11, 126.76, 126.81, 128.17, 128.21, 128.7, 139.6, 139.7, 221.09, 221.11; IR (neat) 2110, 1740 cm$^{-1}$; MS (CI) *m/e* 258 ($M^+ + 1$), 215; HRMS calcd for $C_{15}H_{20}N_3O$ (M + H): 258.1606, found 258.1615.

**6-Azido-6-phenyl-2-hexanone (7):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.52−1.84 (m, 4H), 2.10 (s, 3H), 2.43 (t, $J$ = 7.4 Hz, 2H), 4.41 (t, $J$ = 6.4 Hz, 1H), 7.26−7.39 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 20.4, 29.8, 35.4, 42.9, 66.1, 126.8, 128.2, 128.7, 139.4, 208.1; IR (neat) 2120, 1725 cm$^{-1}$; MS (CI) *m/e* 218 ($M^+ + 1$), 175; HRMS calcd for $C_{12}H_{16}N_3O$ (M + H): 218.1293, found 218.1286.

**7-Azido-7-phenyl-2-heptanone (8):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.25−1.40 (m, 3H), 1.55−1.61 (m, 3H), 1.73−1.89 (m, 2H), 2.12 (s, 3H), 2.42 (t, $J$ = 7.3 Hz, 2H), 4.41 (t, $J$ = 6.7 Hz, 1H), 7.26−7.38 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 23.2, 25.7, 29.8, 35.9, 43.3, 66.1, 128.2, 128.3, 128.7, 139.6, 208.6; IR (neat) 2100, 1710 cm$^{-1}$; MS (CI) *m/e* 232 ($M^+ + 1$), 189; HRMS calcd for $C_{13}H_{18}N_3O$ (M + H): 232.1450, found 232.1458.

**General Procedure for $TiCl_4$-Promoted Intramolecular Schmidt Reaction of Azides.** To a solution of azide (0.18 mmol) in $CH_2Cl_2$ (4 mL) at 0 °C was added $TiCl_4$ (0.46 mmol) over a 10 min period. The resulting solution was allowed to stir at 0 °C for ca. 15 min. The reaction was then quenched with saturated $NaHCO_3$ and diluted with water and $CH_2Cl_2$. The layers were separated, and the aqueous layer was extracted with $CH_2Cl_2$. The combined organic layers were washed with brine, dried over anhydrous sodium sulfate, and concentrated in vacuo to afford both diastereomers of lactam as a light brown oil (see Table 1 and Scheme 3 for yields).

**1-Aza-9-phenylbicyclo[4.3.0]nonan-2-one (10):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.24−2.46 (complex, 10H), 3.55−3.63 (m, 0.5H), 3.71−3.79 (m, 0.5H), 5.11−5.16 (m, 1H), 7.11−7.32 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 20.8, 21.3, 28.7, 29.5, 30.1, 31.2, 31.5, 32.9, 33.0, 33.4, 60.0, 60.2, 60.4, 125. 3, 125.4, 126.4, 126.5, 128.2, 128.4, 143.2, 143.7, 168.9, 169.2; IR (neat) 1655 cm$^{-1}$; MS (CI) *m/e* 216 ($M^+ + 1$); HRMS calcd for $C_{14}H_{18}NO$ (M + H): 216.1388, found 216.1385.

**1-Acetyl-2-phenylpyrrolidine (16):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.84 (s, 2H), 1.86−1.95 (m, 3H), 2.15 (s, 1H), 2.23−2.57 (m, 1H), 3.58−3.77 (m, 2H), 4.91 (m, 1H), 5.22 (dd, $J$ = 1.7, 6.1 Hz, 1H), 7.13−7.36 (m, 5H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 21.8, 22.5, 22.7, 23.6, 34.0, 36.2, 46.9, 48.3, 60.1, 62.2, 125.30, 125.34, 126.5, 127.2, 128.3, 128.7, 142.8, 143.1, 169.2, 170.2; IR (neat) 1660 cm$^{-1}$; MS (CI) *m/e* 190 ($M^+ + 1$); HRMS calcd for $C_{12}H_{16}NO$ (M + H): 190.1232, found 190.1236.

**General Procedure for TfOH-Promoted Intramolecular Schmidt Reaction of Azides.** To a solution of azide (0.21 mmol) in $CH_2Cl_2$ (7 mL) at 0 °C was added TfOH (0.27 mmol) over a 10 min period. The resulting light, clear yellow solution was allowed to stir at 0 °C for ca. 15 min. The mixture was then quenched with saturated $NaHCO_3$ and diluted with water and $CH_2Cl_2$. The layers were separated, and the aqueous layer was extracted with $CH_2Cl_2$. The combined organic layers were washed with brine, dried over anhydrous sodium sulfate, and concentrated in vacuo to afford a yellow oil. Chromatography (20−60% EtOAc/hexanes) afforded both diastereomers of lactam as a light yellow oil (see Table 1 and Scheme 3 for yields).

**General Procedure for TfOH-Promoted Intramolecular Mannich Reaction of Azides.** The procedure used was similar to the above except that 2 equiv of TfOH were used in place of $TiCl_4$ for ca. 4 h reaction time. Chromatography (0−3% EtOAc/hexanes) allowed for individual isolation of both diastereomers of Mannich product as clear, colorless oils (see Table 1 and Scheme 3 for yields).

***cis*-6-(Phenylamino)spiro[4.4]nonan-1-one (12a):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.52−2.24 (complex, 12H), 3.77 (t, $J$ = 6.3 Hz, 1H), 4.15 (br s, 1H), 6.58 (m, 2H), 6.66 (m, 1H), 7.13 (m, 2H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 19.8, 22.2, 33.0, 35.5, 37.7, 38.9, 58.6, 62.1, 113.4, 117.2, 129.2, 147.6, 223.2; IR (neat) 3410, 1725 cm$^{-1}$; MS (CI) *m/e* 230 ($M^+ + 1$); HRMS calcd for $C_{15}H_{19}NO$: 229.1467, found 229.1466.

***trans*-6-(Phenylamino)spiro[4.4]nonan-1-one (12b):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.41−2.31 (complex, 12H), 3.62 (br s, 1H), 4.14 (dd, $J$ = 2.0, 7.4 Hz, 1H), 6.48 (m, 2H), 6.64 (m, 1H), 7.11 (m, 2H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 19.6, 21.7, 31.7, 34.5, 37.84, 37.86, 58.5, 59.3, 113.0, 117.2, 129.3, 147.2, 224.1; IR (neat) 3400, 1720 cm$^{-1}$; MS (CI) *m/e* 230 ($M^+ + 1$); HRMS calcd for $C_{15}H_{19}NO$: 229.1467, found 229.1465.

**1-(Phenylamino)-2-acetylcyclopentane (17):** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.46−1.57 (m, 1H), 1.70−1.84 (m, 3H), 1.97−2.06 (m, 1H), 2.10−2.17 (m, 1H), 2.18 (s, 3H), 2.77−2.83 (m, 1H), 3.65 (br s, 1H), 4.12 (q, $J$ = 5.6 Hz, 1H), 6.56 (d, $J$ = 7.7 Hz, 2H), 6.70 (t, $J$ = 7.3 Hz, 1H), 7.14−7.17 (m, 2H); $^{13}$C (100.6 MHz, $CDCl_3$) $\delta$ 24.0, 28.6, 29.5, 33.9, 56.8, 59.1, 113.4, 117.6, 129.3, 147.3, 210.4; IR (neat) 3420, 1710 cm$^{-1}$; MS (CI) *m/e* 204 ($M^+ + 1$); HRMS calcd for $C_{13}H_{18}NO$ (M + H): 203.1388, found 204.1378.

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**Supporting Information Available:** Additional compound characterizations and copies of $^1$H and $^{13}$C NMR spectra of new compounds. This material is available free of charge via the Internet at http://pubs.acs.org.

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